

## **DoD Energy Security Task Force**

The Department has made progress to incorporate energy considerations in its planning and business processes. In May 2006, the Secretary of Defense commissioned the Director, Defense Research and Engineering to chair the Energy Security Task Force (ESTF) to define an actionable investment roadmap for lowering DoD's fossil fuel requirements and developing alternate fuels for use by the Department. The Task Force is comprised of senior leaders from across the Department with a stake in energy, including requirements development, technology, acquisition, logistics, installations and environment, policy, and the budget. By taking a systems approach, integrating different functional areas, we can better understand the indirect and potentially negative unintended consequences of various courses of action, thereby improving decision making for the Department.

Energy is a strategic resource that has significant security, economic, geo-strategic and environmental implications for the nation and important operational implications for the Department. For example, in FYs 2006 and 2007, DoD's total energy costs exceeded \$13 billion, and an additional \$5 billion has been requested in FY 2008 obligational authority to ensure we could support the increased fuel costs. Like the nation, DoD must focus on reducing demand through culture change and increased efficiency. The intensity of day-to-day fuel demand in Iraq and Afghanistan is greater than in any war in history. This has required ever greater numbers of large logistics convoys along vulnerable lines of communication that are prime targets for insurgent forces. Protecting these convoys impose a high burden on our combat forces, by diverting combat units from direct engagement to force protection missions. This will continue to be a burden in any scenario in which we face an asymmetric threat, from almost any potential foe. The strategic importance of energy security is well appreciated by decision-makers. However, Operations Iraqi Freedom and Enduring Freedom have reminded us that energy is tactically relevant, and field commanders are looking to the Department and Services to provide battlefield solutions that reduce vulnerability but also increase capability.



**Fuel convoys in Iraq**

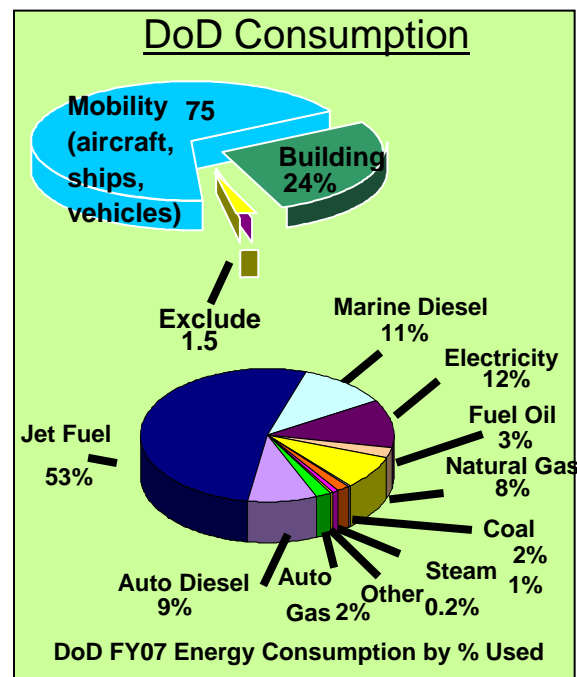
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The Secretary of Defense has designated energy initiatives as one of the Department's Top 25 Transformational Priorities, and the Military Departments have established energy leads and task forces, responsible for overseeing all energy efforts. The Department is currently working to better understand the value of energy in terms of cost and operational capability, and to modify business processes to more accurately integrate those values into decisions that affect requirements planning, acquisition and funding priorities.

The Services have established organizational processes for integrating energy efforts and issues. The Army recently named the Deputy Assistant Secretary of the Army for Privatization and Partnerships as their energy executive and has created an Army Energy Security Task Force to address cross-functional issues. The Navy is setting up a Navy Energy Task Force to provide a comprehensive Navy energy governance structure, and for several years, the Air Force has had a well-defined structure, led by the Assistant Secretary of the Air Force for Installations and Environment, with several technical panels underneath.

DoD is developing an Energy Strategic Plan which lays out four outcomes that cross functional areas and describe a desired future state for the Department with respect to energy. They are:

1. Maintain or enhance operational effectiveness while reducing total force energy demands.
2. Enhance operational and business effectiveness by institutionalizing energy solutions in DoD planning and business processes.
3. Increase energy security through strategic resilience by shifting reliance toward alternative and renewable sources of energy, reducing dependence on non-assured sources of oil, stabilizing – or reducing – our operational energy demand, and leveraging efforts by other organizations, like federal agencies, industry, academia, and the international community.
4. Establish and monitor Department-wide energy metrics.



#### **Energy considerations in the acquisition process:**

The acquisition process is currently under revision to more accurately value energy. In April 2007, the Under Secretary of Defense (Acquisition, Technology and Logistics)

signed a policy memorandum to use the fully burdened cost of fuel (FBCF) as a major basis for all trade analyses for acquisition programs. The memo also established three pilot programs – the Joint Light Tactical Vehicle, alternative ship propulsion for the next generation cruiser (CG(X)) and the Next Generation Long Range Strike (Next Generation Bomber) – to validate the approach and to facilitate development of policies and procedures for how to apply it in the acquisition process. We expect to have guidance for the relevant acquisition procedures in place by October 2008 and will use the insights to develop procedures for establishing energy as a key performance parameter, an attribute or characteristic of a system that is considered critical or essential to the development of an effective military capability.

### *Operational Efficiencies/Optimization and Commercial Practices*

#### **Technology demonstrations to support the warfighters:**

In an effort to demonstrate the efficacy of demand reduction coupled with alternative/renewable power, the Power Surety Task Force and the National Training Center, at Fort Irwin CA, installed energy efficient structures (domes, Spray-Foam insulation, renewable power generator, efficient heating, ventilating, and air conditioning systems) in the training area, designed to replicate a forward operating base. These structures show ground commanders how a holistic approach can provide an estimated energy savings of about 60 percent. This proof of concept effort was completed in just over 90 days and was the forerunner of the Net-Zero Plus Joint Concept Technology Demonstration (JCTD) sponsored by the U.S. Central Command to make forward operating bases energy independent for power generation.

The JCTD will prototype, measure and assess a variety of technologies that collectively would use less energy than they create and determine which, if any, should be recommended for inclusion in sustainable design efforts in the Installations' community. As a



**Monolithic dome and renewable energy generator at NTC**



**Foamed tents at Forward Operating Base in Afghanistan**

result of these demonstrations, Ft. Irwin leaders are considering the expansion of these technologies to their entire base. According to their analysis, a \$25 million investment has the potential to save \$105 million in five years with a break-even point of nine months.

In July 2007, the Power Surety Task Force and U.S. Army's Rapid Equipping Force demonstrated a technique for insulating temporary structures such as tents and containerized living units using an exterior application of spray foam. The resulting energy savings of 40 to 75 percent caused Multi-National Force Iraq to award a \$95M contract to insulate nine million square feet of temporary structures. Based on extrapolated data from previous demonstrations, the additional nine million square feet of insulated temporary structures could save over 77, 000 gallons of fuel per day in theater, equivalent to about 13 truckloads of fuel, with associated cost savings of \$230,000 per day at \$3 per gallon (not including the military logistics and force protection saved from the demand reduction).

The Power Surety Task Force and the Army's Rapid Equipping Force are demonstrating spray foam insulation and a solar power and storage system in Fort Belvoir housing in July 2008. The Fort Belvoir demonstration will include a "control" case (with no energy technologies), then test the effectiveness of several technologies in three additional houses, each with successively increasing energy technologies. This \$115,000 demonstration will provide data enabling us to determine the most cost effective combination of insulation and solar cells. If successful, the insulation, at a minimum, could be retrofitted in many attics and office buildings on all military installations to achieve significant savings.

The U.S. Army's Rapid Equipping Force has deployed two Tactical Garbage to Energy Refineries (TGER) to Iraq for a capability demonstration. TGER converts field waste (paper, plastic, cardboard and food slop) into biofuel that is used to power a 60 kilowatt generator. A battalion sized forward operating base (600-800 soldiers) creates about one ton of garbage per day that can be recycled into energy, so the system is designed to convert 1 ton of waste into energy equal to about 115 gallons of JP-8. It is skid mounted and deployable on a military 5-ton flatbed trailer. The units were deployed in April 2008 and will undergo a 90 day evaluation in theater, whereupon a transition decision will be made regarding further development or deployment.

#### *Fuel Optimization for Mobility Platforms*

The Department is exploring technologies that would increase fuel efficiency for its platforms and systems. We are combining efforts in a variety of technical areas, including lightweight materials and armor, novel structural shapes and more efficient engines, to identify ways to reduce fuel consumption affordably and sustainably.

**Fuel efficiency for turbine engines.** The Highly Efficient Embedded Turbine Engine (HEETE) initiative, part of the Versatile Affordable Advanced Turbine Engine (VAATE) program, is developing a high-pressure ratio, high temperature core technology, with the potential to reduce specific fuel consumption up to 25 percent over today's systems.

HEETE is addressing the highest technical risk element in new engine development – the high pressure compressor component development. The current schedule includes a rig test in FY 2010, demonstrating a technology readiness level four or five in a laboratory or relevant environment. These technologies are applicable to all turbine engines and also can be used in commercial aircraft.

**Efficient engines for Unmanned Aerial Vehicles (UAVs) and generators.** The Small Heavy Fueled Engine demonstration is a three year program, initiated in FY 2008, and is anticipated to increase fuel efficiency and power density by 20 percent for UAVs and generators. The three engines assessed in the demonstration will operate on heavy fuels such as JP-8, thereby reducing the number of different fuels used on the battlefield and reducing the strain on the logistics tail.

**Testing fuel efficient equipment on ground vehicles.** The Fuel Efficient Demonstrator (FED) is testing the feasibility and affordability of achieving significant decreases in fuel consumption in a tactical vehicle, without sacrificing the performance or capability. This program is integrating potentially high-payoff fuel efficient technologies, like efficient propulsion and drivelines, and advanced lightweight materials in new and innovative designs. Successful technologies may be incorporated in future procurements for the Joint Lightweight Tactical Vehicle (JLTV). FED is employing a concurrent parallel strategy, combining a traditional systems integrator approach with a “monster garage” approach, which are projected for award in June 2008. This program will also benefit the science and engineering workforce, by providing hands-on experience across a broad range of technical areas. High-potential government engineers from across DoD will work side-by-side with the contractor engineers in one year developmental assignments, building skills in vehicle design, systems engineering, vehicle integration, modeling and simulation, testing, and project management.

#### *Facility Energy Initiatives*

The Installations' Community has made significant progress in reducing energy consumption (over 30 percent since 1985) and increasing energy from renewable sources. In FY07, the Department reduced energy usage by over 10 percent from the 2003 baseline and almost 12 percent of our electricity was generated from renewable energy sources.

The Department established an implementation committee, led by the Deputy Under Secretary of Defense for Installations and Environment, to address the goals set forth in recent federal energy guidance, including the Energy Policy Act of 2005, Executive Order 13423: “Strengthening Federal Environmental, Energy, and Transportation Management” and the Energy Independence and Security Act of 2007. The



**Fig. 5. Nellis Air Force Base solar array**

Implementation Committee is coordinating and prioritizing these initiatives and is serving as a conduit to the Energy Security Task Force for installation issues. The Department has a head start in achieving these goals with the initiatives outlined below.

**Solar power.** Solar power is the largest contributor in the Air Force's renewable energy development program. In December 2007, the Air Force commissioned the largest photovoltaic solar array in the Americas (14.2 megawatts) at Nellis. This supports about one fourth of the base's energy usage per day and has an estimated annual cost savings of \$1 million. In 2007, the Air Force continued to lead the federal government in green power purchases, with 37 bases meeting some portion of their base-wide electrical requirements from commercial sources of wind, solar, geothermal, or biomass. They are planning to add additional solar projects on underutilized land using the enhanced used lease authority and issued a request for qualifications in January 2008.

**Geothermal power.** The Navy has made good use of the authority in 10 U.S.C. 2922a to receive revenues from geothermal power facilities, as they have done with the development of the 270 megawatt plant at China Lake, California in the 1980s that provides enough power to supply electricity to 180,000 homes. The Navy recently awarded a 30+ megawatt plant at Fallon Naval Air Station, Nevada, and the Department is looking at other opportunities for similar public/private ventures. The Department is considering requesting expansion of the title 10 authority to allow us to receive revenue for other energy resources on DoD lands. Ground source heat pumps are increasingly being used, particularly at housing units.



**Fig. 6. Geothermal power plant at China Lake**

**Testing other potential energy generation technologies.** The Navy also is testing other energy sources for their feasibility to produce energy cost effectively. The Navy installed the first wave power buoy at Marine Corps Base Kaneohe Bay and is partnering with industry to test a second buoy technology. The Navy also is contracting with a commercial firm to provide a technology demonstration of tidal energy harvesting in the Puget Sound area. The Navy is partnering with British Government to design and install a barge mounted off-shore Ocean Thermal Energy Conversion (OTEC) plant for electrical and water requirements at Diego Garcia.

**Net-Zero Plus Initiative at the National Training Center (NTC), Fort Irwin, California.** NTC is currently exploring the feasibility of removing their facilities completely from the electric grid (making them energy-secure) and could have the

potential to sell “green” energy back to the California grid. The Army has named Fort Irwin as the Net-Zero Plus Installation and supports taking Fort Irwin off the grid.

### *Domestic Energy Supply and Distribution*

The Department is pursuing a variety of efforts in alternative fuels, primarily focused on testing and certification, enabling our systems to use different fuels, regardless of the feedstock or production method. We already rely on local fuel sources in theater, like Jet-A1 in Europe, which differ slightly from JP-8. Efforts include improving the combustion process of engines using alternative fuels, optimizing fuel composition, understanding the equipment and systems impacts of alternative fuel use, like corrosion and wear, and establishing protocols for alternative fuels qualification in aircraft, ships, vehicles and generators.

**Synthetic fuel (synfuel) certification.** Several efforts by the Services are underway to test and certify synfuels. For example, in August 2007, the Air Force certified the B-52 to use a 50/50 blend of synthetic fuel (synfuel) blend. Tests are underway to certify the C-17, B-1, and F-22 in the near future, with an objective to certify the entire fleet by early 2011. In December 2007, a C-17 completed the first transcontinental flight using a synfuel blend, and a B-1 flew at supersonic speeds using a synfuel blend in March 2008, demonstrating the applicability of synfuels for operational use. The Air Force has a goal to obtain 50 percent of its fuel used in the continental U.S. from domestic sources that utilize carbon capture and effective reuse by 2016. In addition The Army is testing a wide range of alternative fuels at the Army Research, Design, and Engineering Command in Warren, Michigan.

The Air Force is developing an Assured Aerospace Fuels Research Facility to support the study and evaluation of how processing and upgrading operations, conditions, and catalysts impacts the production, characteristics, quality, and carbon dioxide (CO<sub>2</sub>) footprint of jet fuel made from alternative sources. Joint studies sponsored by the Air Force and the Department of Energy (DOE) show potential life cycle CO<sub>2</sub> reductions below that of conventional petroleum if waste biomass is combined with coal to produce aviation fuels via Fischer-Tropsch (FT) processing. This facility will enable the Air Force to conduct a comprehensive analysis of the potential that biomass may offer to reduce the life cycle CO<sub>2</sub> footprint of FT technology. Looking beyond FT fuels, the Air Force, in partnership with the Defense Advanced Research Projects Agency (DARPA) and industry, is investigating the suitability of second and third generation biomass-derived transportation fuels (e.g., cellulosic biomass, algae oils, animal fats, etc.) as renewable feedstock options for aviation use.



**Fig. 7. C-17 transcontinental flight**

The Navy is conducting research on the effective use of alternative logistics fuels in naval power systems. These efforts include addressing the impacts these fuels have on engine internals and fuel distribution system components, optimizing fuel composition and improving the combustion process. The Navy also is establishing protocols for alternative fuel qualification for use on naval vessels and aircraft.

The Services and the Defense Energy Support Center are also working closely with the Commercial Aviation Alternative Fuels Initiative (CAAFI) that represents the airlines, airports, and manufacturers to efficiently and economically certify the commercial airline fleet. This effort builds on the fact that many aircraft in the commercial and military fleets share common platforms, systems and engines.

**Investment in biofuels.** Commercially available biofuels are in limited supply and have lower energy density than their petroleum-based equivalent. Research suggests that some bio-based feedstocks could be converted into hydrocarbon fuels efficiently and affordably. Since the military's primary fuel source is jet fuel, the Defense Advanced Research Projects Agency (DARPA) is demonstrating the ability for oil rich crops, such as algae, cuphea and jatropha, to create JP-8 at energy density levels sufficient to power military systems. The Defense Advanced Research Projects Agency (DARPA) is soliciting research proposals for technologies that could enable the affordable production of jet fuel alternatives using agricultural or aquacultural crops that are non-competitive with food material (<http://www.darpa.mil/baa/baa08-07.html>).

**Carbon capture and reuse.** In FY 2007, the Air Force and the Office of the Secretary of Defense collaborated with the Department of Energy's National Energy Technology Laboratory (DOE/NETL) and Arizona Public Service in a program to develop a method to use algae to reuse CO<sub>2</sub>. The work involves development of an algae-based CO<sub>2</sub> absorption system which produces algae oils that can be further developed into jet fuel. The Air Force helped develop the establishment of a laboratory at Arizona Public Service to study this algae oil-to-jet fuel process. Currently, the Air Force is preparing to conduct limited work with DOE/NETL in a joint FY 2008 program to look at options for carbon capture and reuse. The Air Force is also beginning to collaborate with DOE's Idaho National Laboratory to expand efforts involving CO<sub>2</sub> capture and reuse.

**Very high efficiency solar cells.** DARPA demonstrated breakthrough conversion efficiency with a set of solar cells – over 42 percent – and is currently using this set in a proof-of-concept solar power module with an objective of 40 percent efficiency, which would be almost double that of current solar power modules. The end-of-program goal is to achieve 50 percent efficiency affordably at the module level. The DARPA module is using a novel lateral cell design that will be optimized in spectrally split band gaps (high, medium-high and low). If successful, this could be a game changer, making solar energy cost effective.

*Tactical Power Systems and Generators*

**Transportable Hybrid Electric Power Stations (THEPS)** The U.S. Army's Rapid Equipping Force completed testing of Transportable Hybrid Electric Power Stations. These devices were requested by Major General Zilmer in response to the vulnerability of his Marines in the Al-Anbar province while delivering fuel. Although significant fuel savings were found, the systems were not robust enough for forward operating base environment, however the insights from this effort were used to advance the Hybrid Intelligent Power program.

**Hybrid Intelligent Power (HI-Power) generator (HI-Power).** The HI-Power program is a revolutionary effort that will develop and validate a DoD standard tactical intelligent power management architecture that incorporates source management (including the use of renewable energy sources where applicable), energy storage technologies, power distribution, and demand management.

Solutions currently being pursued include the development of active distribution networks and intelligent / automated hybrid power systems. Power management and distribution techniques will enable maximum power utilization with a high degree of efficiency for use with various mobile and portable applications in the 2 to 500 kilowatt range.

This power management architecture will include small and medium sized tactical versions for mobile forces and larger transportable systems appropriate for forward operating bases. Initial models estimate fuel savings of up to 40 percent, reduced maintenance and personnel requirements, and fewer power interruptions. The resulting architecture shall impose minimum impacts on transportability, deployability, and readiness levels of current and upcoming platforms.

**Solid Oxide Fuel Cells.** The Navy is developing and demonstrating a compact and mobile 10 kilowatt high temperature fuel cells to power critical equipment, including GPS, radio and communications equipment, computers, intelligence, surveillance and reconnaissance gear, and laser designators. These systems provide silent, portable power and eliminate dependence on large generator or grid power for battery charging. These fuel cells are demonstrating a high efficiency (about 55 percent) and are being designed to be compatible with kerosene-based jet fuels such as JP-5 and JP-8. They will also provide low weight for the available energy content to the soldier carrying them. Additionally, they will provide auxiliary power for applications on vehicles for missions over 24 hours.

**Remote Site Tactical Hybrid Power.** A former Brigade Commander in Iraq, COL Dave Bishop 3rd Brigade; 1st Armored Division, used excess electricity generated from his Forward Operating Base (Camp Taji) to provide power to the local Iraqi population as part of his engagement strategy to facilitate better community relations. This resulted in enhanced security for local population, enhanced security for coalition forces and created a safe and secure environment through a more cooperative relationship with the local population.

Expanding on this success, the Rapid Equipping Force has selected a vendor to deploy a hybrid generator (wind, solar, battery storage, back-up diesel) for a US Forces at a Kuwaiti border crossing communications site, based on an assessment by the Power Surety Task Force. The intent of this effort is to demonstrate the efficacy of commercial hybrid power stations in meeting military needs in isolated, but fixed locations. A 90 day evaluation period will precede the final disposition decision.

More information on sharing energy insights across the federal government and within the local community can be found at <http://www.energyconversation.org>.